HAND BOOK
on
Warp Sizing

PRICE
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C. J. TAGLIABUE MFG. CO.
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To the Reader:—

THIS Hand Book is not intended as a compendium on warp sizing but is designed to place in the hands of the practical man, some exact facts covering several important points. It is hoped that it will help to make better weaving warps.

Slashing of Cotton Warps

By Prof. Everett H. Hinckley
New Bedford Textile School

IMPORTANCE OF SLASHING

In the manufacture of cotton cloth, there is no process of which the actual cost bears so remote a relation to its value as in the slashing of warps. The organization of the mill may be such that the cotton passes through the usual stages of preparation as picking, carding, combing and spinning without undue waste, producing a uniform product. Yet, as a result of poor slashing, the weaving department will be operated only with great difficulty.

As a result of these conditions, production drops, seconds increase and the operatives grow dissatisfied. Although the overseer of weaving and his assistants do their best, they cannot overcome these adverse conditions. Adjustment of tension, temperature and moisture will help to remedy the situation, but by no means cure it.

Important as slashing is, it is frequently regarded by the management as of minor importance and does not receive the attention it should. There are several reasons for this situation. The process involves the use of hot sticky liquids, hence is not always neat. This produces conditions which do not appeal to the imagination of one with a mechanical or systematic turn of mind. Casual observation by the superintendent cannot disclose whether the size mixture is right. The word of the slasher-tender must be accepted with almost no chance to verify his word.

The process of slashing, compared with that of spinning or weaving, is very rapid. The amount of damage caused by any errors in judgment of the operator, thus extends through considerable of his product before correction can be made. In fact, these faults sometimes are not found until the goods are dyed and finished. As the warps are not all put in the looms at once, the extent of the damage is often not realized for several weeks. By this time it is too late to correct it. Thus, the results obtained in slashing, contain elements largely due to the personality of the overseer and his slasher-tenders. *The payment of dividends is directly affected by a small group of men controlling a single operation*

PROCESS OF SLASHING

Control of the several factors in slashing would prevent this undesirable condition. These factors are:

(a) The nature of starch used;
(b) The nature of sizing compound used;
(c) The cooking of the "size" mixture;
(d) The method of applying the "size";
(e) Condition of drying;
(f) Mechanical condition of slasher.

To obtain the best results in slashing, we must use the most suitable starch and "sizing" compound, see that the *time* and *temperature* of cooking are right, have proper pressure on the squeeze rolls and the size in the sow box at the right heat, have the drying cylinders properly heated, and be sure that the adjustment of the driving gears is right.

The determination of what is best in each case usually rests with the overseer of slashing and his slasher-tenders. These men often obtain results that reflect good judgment and keen observation. For a particular mill, each one of the above factors may be made standard if full advantage is taken of modern devices. It is our purpose to direct how this may be done.

MATERIALS USED

Of the starches available, good practice dictates that corn is suitable for coarse yarns and potato for fine yarns. In place of potato, tapioca starch may be used. Thin boiling corn starches are also used for the same purpose. Commercial starches are offered on the market in a high state of purity. The amount of moisture they contain is very important and varies greatly with weather conditions. It will vary so much that mixtures made carefully by weight do not give uniform results. On one day 100 lbs. of starch may contain 12 lbs. of water, and starch taken from the same barrel the next day may carry 20 lbs. of water in each 100 lbs. taken. A simple and practical way of meeting this difficulty is to measure the starch by volume instead of by weight, thus the measuring of the starch is not difficult.

The "sizing" compounds on the market offer a wide field for selection. While there are a great number of these compounds, their ingredients can be classed under four heads:

(a) Fats, as tallow or cotton seed oil;
(b) Soaps, made from animal or vegetable fats;
(c) Chemicals, as magnesium chloride, acetic acid or caustic soda;
(d) Gums, as dextrine, tragasol, or algin.

The fats and oils assist in penetration, soften and lubricate the yarn. The soaps also lubricate somewhat. They also give stiffness to the yarn. The chemicals act upon the starch in various ways. Acids cause the starch paste to cook thin; caustic soda changes it to a thick gummy material, and salts like magnesium chloride attract moisture to the yarn, thus making it more pliable. The gums usually give a smooth uniform tough coating to the yarn, which resists better the chafing action of the harness and reed. The "sizing" compound as sold, frequently contains two or more of the above materials. Water and starch may also properly be present to make the "sizing" compounds easier to handle in the slasher room.

METHOD OF COOKING

The proper cooking of the size mixture in the kettle always presents problems difficult to handle. Starch is insoluble in cold water and is unacted upon by it. Fig. 1 shows corn

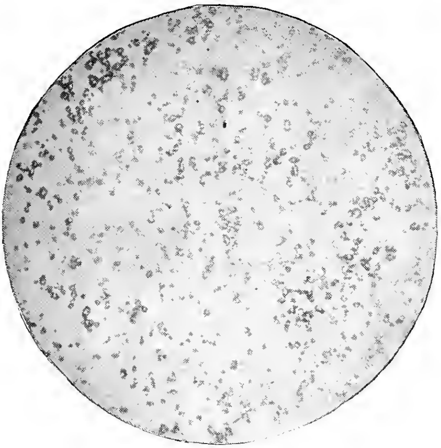


Fig. 1. Corn Starch in Cold Water

starch in cold water as it appears under the microscope. As the water grows warmer, the starch granules swell. Fig. 2 is a micro-photograph of corn starch after it has been heated at 130° F. for 30 minutes. By comparing the size of these granules with those of Fig. 1, a good idea of this swelling action will be obtained. Further heating in water at higher temperatures, causes the starch granules to burst and form a semi-transparent paste. The starch in Fig. 3 has been heated at 160° F. for thirty minutes. Nearly all of the granules are broken up. A few that have been mechanically enclosed in paste, still exist in lumps. By heating the starch at a boil

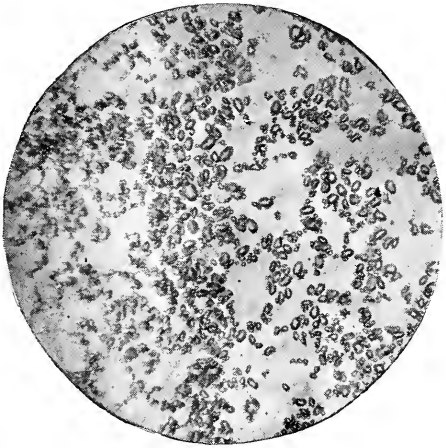


Fig. 2. Corn Starch Heated to 130°F. for 30 min.

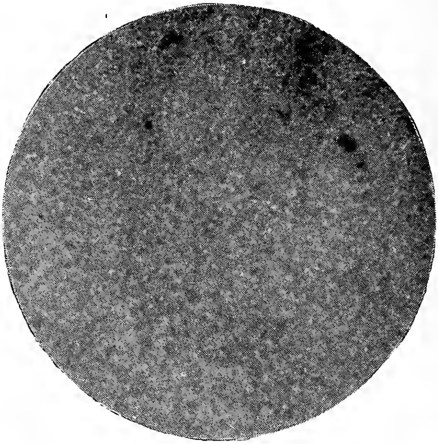


Fig. 3. Corn Starch Heated to 160°F. for 30 min.

all the lumps are broken up and a uniform paste results. Fig. 4 shows a starch in this condition. The vine-like effect is characteristic of a well pasted starch. Continued action of hot water on the starch slowly changes it to sugars that are soluble in water. If acids or salts are present, the action is hastened. These sugars have little value as protecting or stiffening agents for the yarn. If boiled with an open steam pipe, the mixture is diluted with condensed steam. *Hence the cooking of the size is an operation that calls for good judgment and careful control.*

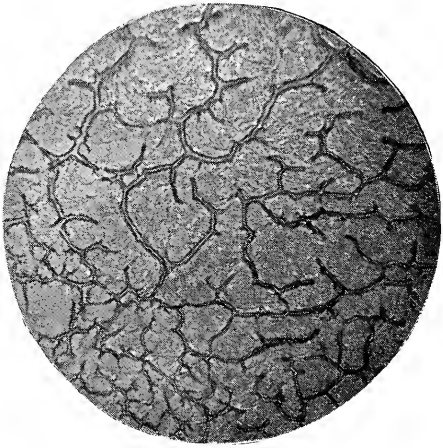


Fig. 4. Corn Starch Boiled

ADJUSTMENT OF MACHINE

Sufficient pressure should be exerted by the squeeze rolls to flatten the yarn out, squeeze out the air and bruise the waxy coating so that when released from pressure, the yarn will suck up the sizing mixture. The sizing mixture in the sow box should be kept hot enough to prevent it skimming over, but not so hot as to cause excessive thinning by chemical changes or dilution with condensed steam. *If the temperature of the size is not uniform*, the drying of the yarn will not be uniform. This will also give hard and soft warps.

The temperature of the drying cylinders is usually kept constant by pressure regulators. Little difficulty arises at this point. As the cylinders are usually housed, there are large losses of heat due to radiation. Hence much more steam is used than required.

The drives, gears and other mechanical connections on the slasher should have frequent attention by a good mechanic. This will prevent undue breakage at the lease rods, prevent over straining of the yarn, and cause the proper "building" of the warp.

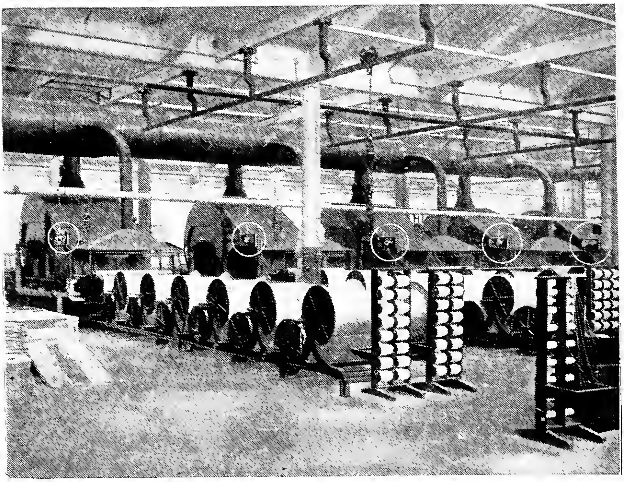
No device will ever do away with the need of careful men to operate the slasher. However, the operator may be assisted to a great extent by the purchase of proper mechanical devices to govern the valuable points to which attention has been called. Of these devices, there is probably none that present opportunities for greater improvements of the slashing process than those *that control the temperatures of cooking and applying the size.*

INFLUENCE OF TEMPERATURE (Coarse Yarn)

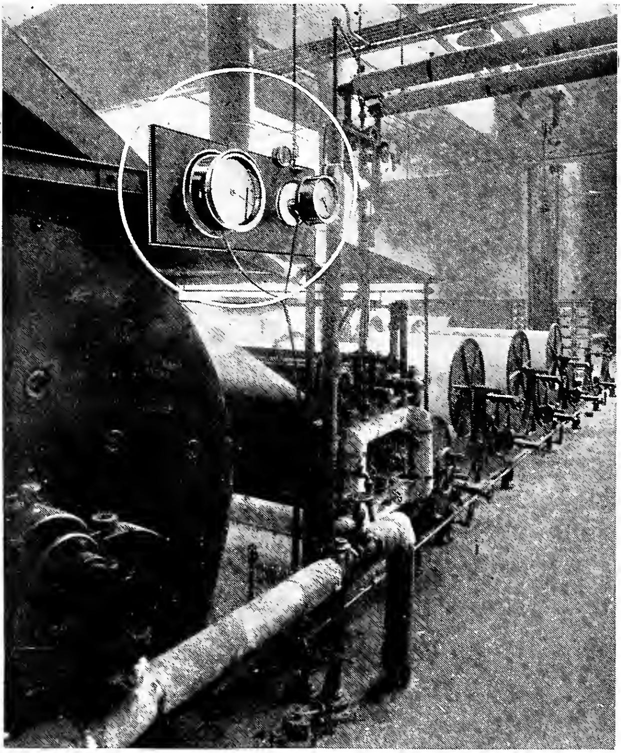
The following article is a report of results obtained in a practical test made at the Naumkeag Steam Cotton Company, December 3, 1918. Slashers at this mill were equipped with Tagliabue Air-operated Temperature Controllers, so that is was possible to carry on the work under *uniform temperature conditions.* Uniform level of "size" in the slasher box was maintained by the use of the Nivling system, whereby the overflow of the slasher box was adjusted to a definite depth and the "size" being constantly circulated by a pump from the main reservoir to each slasher. The "size" was mixed and cooked in separate kettles, one or more of which were continually delivered to the above reservoir so that the results obtained on the various slashers represented the same "sizing" mixture. The machines themselves were practically new and in excellent mechanical condition. Thus, it is believed that in this test superior accuracy was obtained.

WEAVING TEST

The weaving test was carried out on adjacent looms in the same set, all the warps being tied in and started up at the same time. A spare hand acted as observer. The atmospheric condition was fairly uniform, and, of course, as the warps were woven simultaneously was the same for each



The upper picture shows one-half of the slasher-room, illustrating five of the slashers at the Naumkeag Steam Cotton Company Mills. The lower picture illustrates the size box at the far end of the above picture, slightly enlarged, also the "TAG" Automatic Temperature Controller and Recorder.



warp. An accurate record was kept by the spare hand of the yarn breakage over a period of 7½ working days, and finally the fabric was subjected to the usual inspection in the cloth room. Besides the usual qualities such as pick and sley, weight per yard, the tensile strength of the woven cloth was also obtained.

By reference to the micro-photographs shown on pages 4 and 5, it will be readily seen that there are *certain temperature limits* within which a starch paste must be kept in order to keep it uniform in consistency. It is further evident that there must be *some point within these limits* at which the yarn slashed will weave best. As the final criterion of the value of the slashing process must be how the warps weave, especial stress is laid in this article on the results obtained in that test.

TEMPERATURE OF SIZE

From the practical point of view of the slasher-tenders, the "size" in the slasher box should be kept hot enough so that it will not "skin over," and thin enough so as not to cause creeping of the covering on the slasher rolls or "picking up" on the drying cylinders. On the other hand, if the "size" is kept too hot, it will be thinned by the condensation of excess of steam, and also by production of invert sugar. Among practical slashers, there is a wide variety of opinion as to the *proper temperature* at which the "size" should be kept. Some state that actual and constant boiling should take place; others that it should be "very hot"; others "good and hot"; all of which terms to the practical man of long experience mean something fairly definite, but to others of less experience, something quite vague. There are many reasons why there should be this variety of opinion. Chief among these are the facts that the warps vary so much in density, in twist of yarn, and in kind of cotton used. Also, and more difficult to control, is the variation in factor of judgment.

DETAILS OF TEST

Description of Warps:

Yarn	No. 22's
Ends	6168

Cuts per Beam 13 (approximate length of cuts 40 yds.)
Warps drawn in 68 ends per inch, plain weave 2 ends per dent.

Description of Slashing Test:

The warps were run at the following temperatures:

Warps (1) Controlled at 171°F.
" (2) Controlled at 197°F.
" (3) Controlled at 207°F.

The Tagliabue Automatic Controller kept the temperature within such limits that the greatest variation per warp was 3°. The temperatures here given are the average for the period covered by the warp.

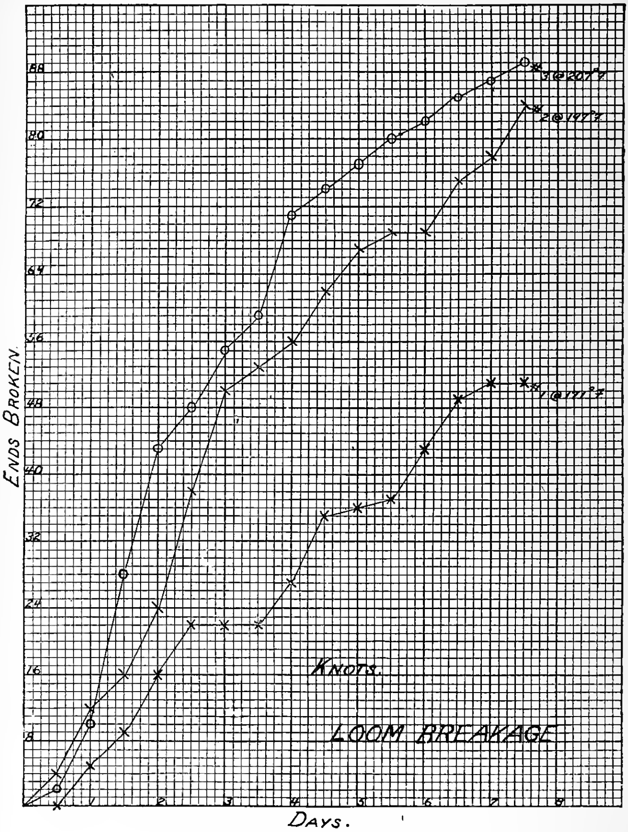


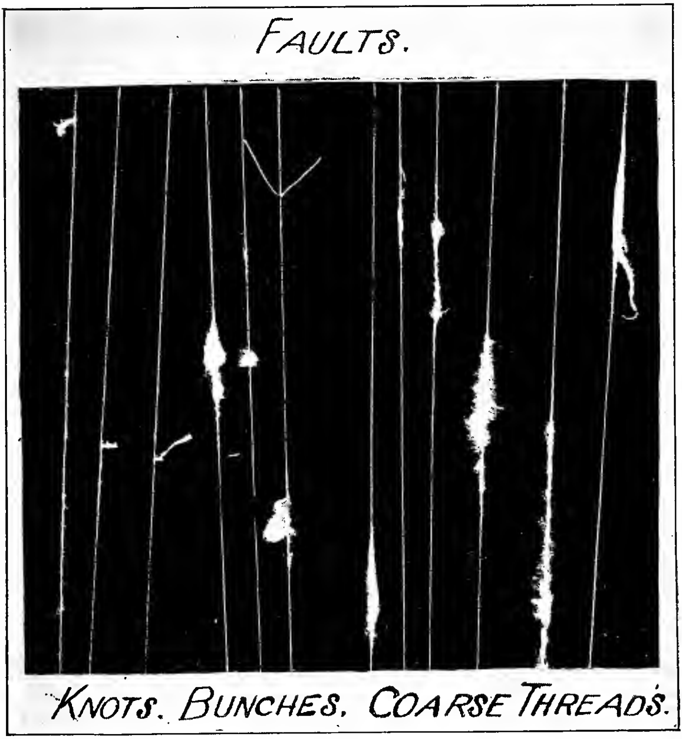
Fig. 1. Warp Breakage due to Knots in Yarn.

EVALUATION OF RESULTS

The cloth was woven on four adjacent 90″ looms, running at the rate of 104 picks per minute. The breakage of yarn in the weaving test was noted and classified in the following manner:

(a) Knots
(b) Coarse threads
(c) Bunches
(d) Unknown

The test was run for 73½ hours (7½ days). Of these faults, there will be some variation from warp to warp, but it is believed this is reduced to minimum in this test by the large quantity of yarn of this number being made at this mill. The known faults are due to spinning and spooling. The size acts as a means to prevent yarn breakage due to these faults. The



Classes of Faults in Warp Yarn.

spoolers' knots being made by machine were very uniform in shape and strength. By the nature of the spooling process, particularly the length of yarns used, these knots are likely to be more nearly equally distributed than any other causes. The coarse threads and bunches, being due to faults such as piecing and uneven conditions in spinning and previous process, are intermittent and by no means regularly distributed. Certain ends broke for which no cause could be given and therefore had to be classed as unknown. Ends broken by catching behind lease rods, catching in the harness or reed, or due to other weaving conditions would be majority of these.

OBJECT OF SIZING

The object of "sizing" of warps is to furnish to each end sufficient strength and resistance to chafing to stand the operation of weaving. In arriving at the value of any conditions of s ashing, due attention must be given to the fact that some of these faults already in the yarn may be incurable. Coarse threads may be so weak that no amount of starch paste will stick them together strong enough to weave. Bunches may be small and weave in without breaking or they may be very

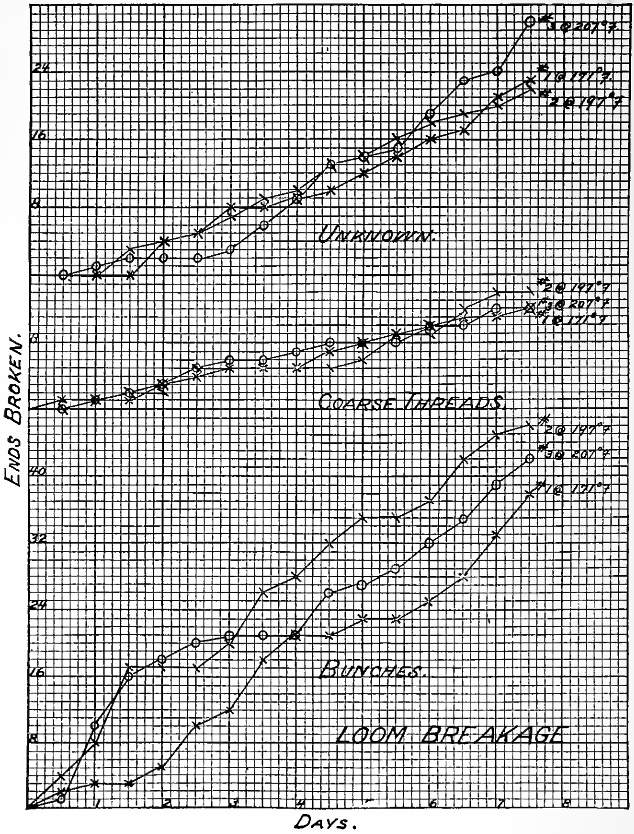


Fig. 2. Warp Breakage due to Bunches, Coarse Threads and Unknown Causes.

large, causing serious breakage. Conditions in slashing that improve the weaving value of coarse threads, would decrease that of the bunches. Coarse threads would weave best if slashed at high temperature where the strongest yarn is obtained. Bunches would weave best if softer, a condition obtained when the "size" is at a lower temperature. Knots would weave best under similar conditions to bunches. In order to arrive at the proper meaning of the results obtained, these facts must be borne in mind.

DISCUSSION OF RESULTS

The results of the record obtained by the observer in the weaving test were analyzed and charts, Figs. 1 and 2, made, showing the breakage due to each of the four causes. From these charts it will be seen that the breakage of warp ends due to knots is lower, the lower the temperature of applica-

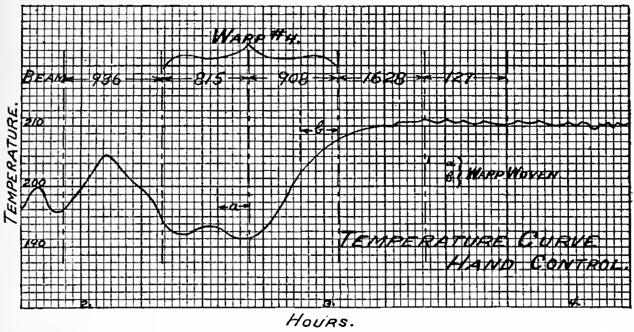


Fig. 3. Temperatures Recorded with Hand Control.

tion of the "size." Further, it is approximately proportional to the temperature. The breakage due to bunches, as would be expected, is very erratic, but the higher temperatures show the most breakage. In the case of the coarse threads, the regularity is more striking, the lowest temperature giving the highest breakage. Unknown causes again give us an irregular chart, but the chart shows in a general way that the breakage is *directly proportional to the temperature.* As all these faults are met with in everyday work, the conclusions to be of value must be based upon the totals.

TABLE 1.

Loom Breakage.

No. of Warp	Knots	Bunches	Coarse Threads	Unknown	Total
1	51	38	12	23	124
2	84	46	14	22	166
3	89	42	12	30	173
Total	224	126	38	75	463

These also show a decided advantage for the lower temperature control, and also retain the breakage proportional to the temperature.

CHECK TESTS

For purposes of comparison, warps were also run on another slasher, using the same kind of yarn and in every way keeping the conditions as near the same as those used for warps 1, 2 and 3, except that the steam was controlled by hand. By referring to Chart 3, it will be seen that the part of this warp woven was sized at an average temperature of 194° F. The results obtained in weaving, confirm in a general way, the conclusions obtained from the controlled temperature work. As this warp was made from another set of warper beams, too close a comparison cannot be made. It is expected that the number of knots, bunches and coarse threads

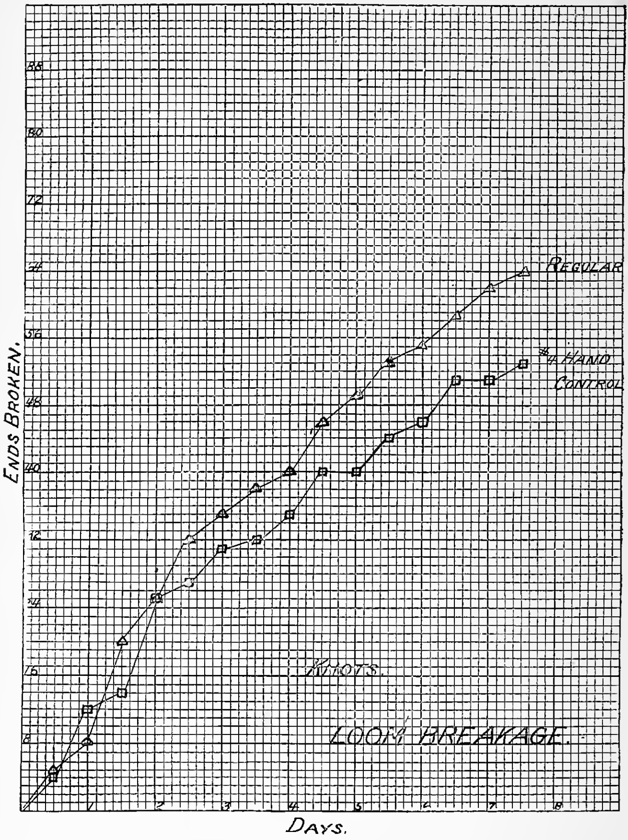


***Fig. 4. Breakage due to Knots in Warp No. 4 and Regulars.**
(Regular refers to Automatic Control)

will vary according to conditions existing in the course of preparation of these beams. Such was the case. The temperature was recorded by a self-recording thermometer, the face of which could not be seen by the operator, he relying solely on his own judgment. Fig. 3 shows the temperature recorded.

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* (Author's note). Referring to charts, figures 4 and 5, the reason hand control shows a trifle better than the results obtained by automatic control is probably due to the fact that "hand control" covered a single warp, which had been better prepared and was more free from knots and bunches. The warps slashed under "regular or automatic control" were the run of the mill. This assumption is strengthened by the fact that breakage from unknown causes were larger on the "hand control."

Of course, if complete reliance was placed on the experimental basis of this test only, there would be an advantage for "hand control" at the temperature noted. However, these tests will undoubtedly appeal more strongly to the practical man in their present form because he is aware of the variations which exists in knots and bunches and knows that these facts must be considered in deciding upon the value of test like these.

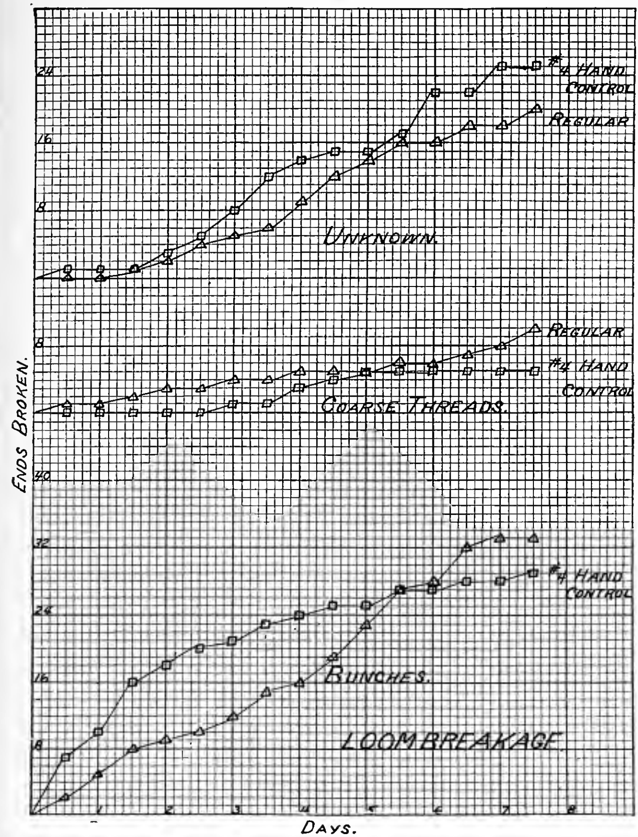


*Fig. 5. Breakage due to Bunches, Coarse Threads and Unknown Causes in Warp No. 4 and Regulars. (Regular refers to Automatic Control)

The results obtained, Table 2, indicate a better condition of yarn before slashing, i. e., fewer knots and other defects. The breakage is lower than any of the other warps except those for unknown causes. The breaks occurring due to the latter, are almost exactly the average of the four warps considered. This further confirms the idea of a better prepared warp before slashing. These results thus confirm the previous deductions.

TABLE 2.

Loom Breakage. (Average Temp. 199°F.).

No. of Warp	Knots	Bunches	Coarse Threads	Unknown	Total
4	53	29	5	25	112

As a further check on these tests, note was taken of the breakage of three other warps running in the same set of looms. These warps were slashed several weeks earlier at a

controlled temperature of 195°F. The average results obtained in these cases, Table 3 and Figs. 4 and 5, are in further confirmation that the *breakage is proportional to the temperature.*

TABLE 3.

Loom Breakage. (Temperature 195°F.).

No. of Warp	Knots	Bunches	Coarse Threads	Unknown	Total
Automatic Control	64	33	10	20	127

CONCLUSIONS.

From the foregoing tests, the conclusion is drawn that the *temperature of application of sizing* has a marked effect on the results obtained in weaving. That for warps, of the type represented by these tests, the lower temperature of application, providing the "size" does not "skin" over, or the rollers slip, the better weaving results. This advantage amounts to approximately one end for each two degrees drop from 210°F. for the warps woven.

In applying the above results in practice, care must be taken not to reduce the temperature of "size" to a point where it will not be properly dried, or where the thinner yarn will not be sufficiently stiffened to stand the weaving. There is also saving in steam but no attempt has been made to ascertain this, nor of the indirect results obtained by relieving the slasher-tender, the boss, and the superintendent of looking after the detail of steam in the size box.

INFLUENCE OF TEMPERATURE (Medium Yarn).

Although the results obtained at the Naumkeag Steam Cotton Mill indicated with considerable directness, that temperatures much below that of boiling water are desirable in the size box, it is thought best to test the accuracy of this conclusion by carrying out another series of tests on different yarns at a different mill, and under entirely different operating conditions.

For this purpose, the New Bedford Cotton Mills Corporation offered the use of their plant. In general, the plan of work was the same as at the Naumkeag Steam Cotton Company. Several warps were slashed under varied, but *controlled* temperature conditions, and the degree of success attained, judged by the results obtained in weaving. Finer yarns and a much denser warp were used and the looms were run faster. The slashing was done on Saco-Lowell slashers. All the warps were run on one machine. None of the usual condition of operation at this mill were altered *but that of temperature.*

DETAILS OF SLASHING

Average speed of machine 25.7 yards per minute; 12 slasher beams of 35s single yarn, 482 ends each, were made up into 10 loom beams; average number cuts per loom beam, 9.7.

The sizing mixture was carefully made to insure uniform quantities of material from vegetable starch, a gum and a

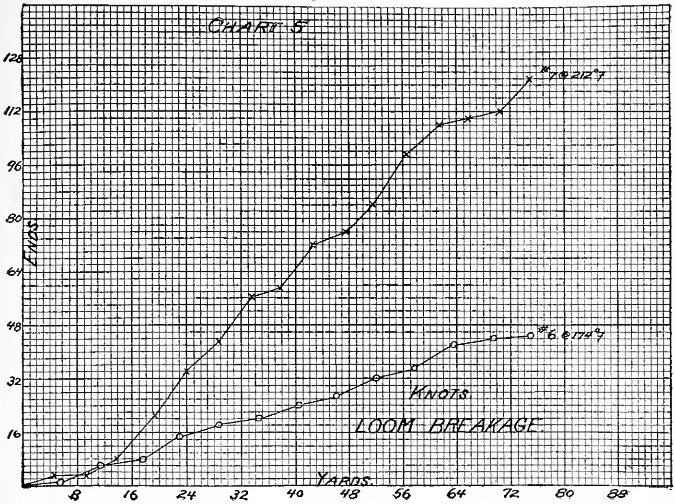


Chart 5. Ends Broken due to Knots. Warps Slashed at the New Bedford Cotton Mills Corporation.

softener. Each mixing was properly boiled, then run into a supply tank from which all the slashers drew their supply. The slasher has two inlet valves for size, one at each end of the size box. These valves were linked together by a steel rod so that both valves opened at the same time. The top squeeze rolls were carefully lapped with a high grade of slasher cloth. The steam pressure in the drying cylinder was kept nearly constant, averaging 12.8 lbs. Each warp was completely dried.

DETAILS OF WEAVING TEST

50″ Crompton & Knowles loom—3 x 3; 156 sley—6 harness plain; 4 ends in a dent; 26 picks of No. 10 filling yarn; 36 inches wide in the cloth; looms run 150 picks per minute.

A special reciprocating-rod was used to open the yarn back of the regular lease rods. Owing to the density of the warp and consequent high breakage of yarn, only one warp could be put in a weaver's set at a time, so the two warps, 6 and 7, used for comparison, were run successively on the same loom. Humidity conditions were fairly constant so that no appreciable variation entered the results by weaving the warps successively.

Further confirmation of the results was made by running another warp, 8, in another set of looms but near the first set. An observer took accurate note of all ends broken out either at the back of the loom or in the shed and classified under causes as "knots," "bunches," "coarse threads" and "unknown." The first three are shown in Fig. 1. This last class comprised ends broken in the shed for which the cause was not readily apparent. Some of the probable causes for these ends breaking are thin threads, slack ends, rough harness eyes and tight ends.

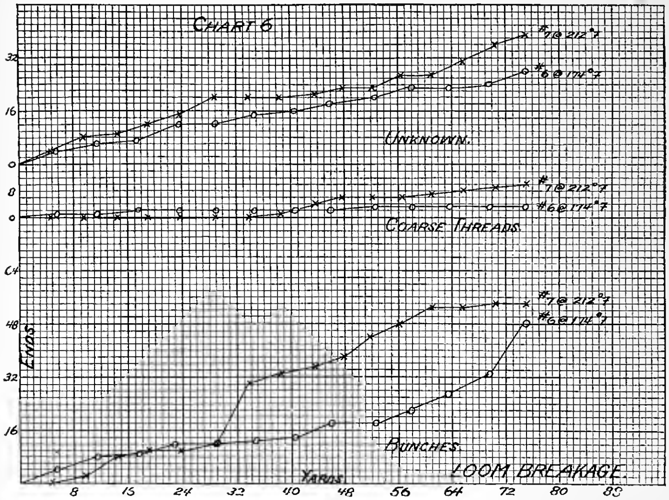


Chart 6. **Ends Broken due to Bunches, Coarse Threads and Unknown Causes. Warps Slashed at the New Bedford Cotton Mills Corporation.**

LOOM BREAKAGE

Two warps, one slashed at 212°F., warp 6, the other at 174°F., warp 7, were woven on the same loom by the same weaver. The results obtained over equal yardage of woven cloth are as follows:

Warp	Temperature of sizing	Knots	Bunches	Coarse Threads	Unknown	Total
6	174° F.	45	48	3	28	124
7	212° F.	122	54	10	39	225

Table 4. Loom Breakage Warps Slashed at Different Temperature.

These results are shown in detail by charts 5 and 6. Comparison of the figures show at once the marked superiority of the warp sized at 174° F. The breakage due to knots of the warp sized at 174° F. is less than half that of the warp at 212° F. The breakage due to bunches is slightly less, but as this fault is accidental no great stress can be laid on this point. The breakage due to unknown causes is nearly one-third less, and that due to coarse threads over two-thirds less than that of the warp sized at 212° F. Faults due to coarse threads should be made to weave better by the sizing, as should also those due to unknown causes. The results obtained must be considered for their face value.

The totals show an advantage of 44.9 per cent. for the warp sized at the lower temperature. A comparison of the charts shows that this advantage was held throughout the test. That is, these results show no evidence of being accidental, but do indicate the true conditions. Hence, better weaving is to be expected from a warp sized at lower temperatures.

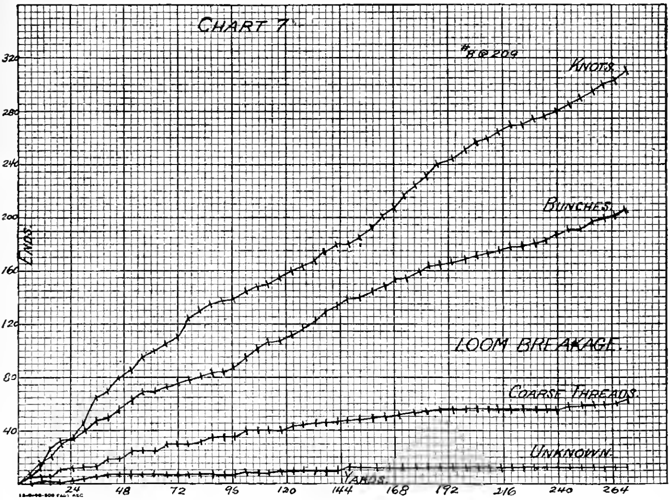


Chart 7. Ends Broken due to Knots, Bunches, Coarse Threads and Unknown Causes. Warps Slashed at the New Bedford Cotton Mills Corporation.

CHECK TEST

In order to check the above conclusion, another warp sized according to the usual method of the mill on the same machine at a controlled temperature of 209° F., was woven in another set of looms. The weaver selected was one of the best in the room and the test run over a much longer period of time. The results are given in table 5. Using the same units as for charts 5 and 6, chart 7 was laid out showing the details of this test.

Warp	Knots	Bunches	Coarse Threads	Unknown	Total
8	309	205	63	13	590

Table 5. Loom Breakage Warp Slashed in the Usual Manner

These results show that the effect on temperature is very regular and the defective ends are inversely proportional to it. Table 6 was prepared to show the ends broken per linear yard woven. Chart 8 gives the graphical comparison of these values:

Warp	Temperature	Knots	Bunches	Coarse Threads	Unknown	Total
6	174° F.	.600	.640	.40	.374	1.654
7	212° F.	1.627	.720	.133	.520	3.000
8	209° F.	1.141	.759	.223	.048	2.181

Table 6. Ends Broken per Linear Yard of Cloth Woven
(New Bedford Cotton Mills Corporation.)

COMPARISON OF TESTS

So evident did this proportional relation appear, that the results obtained at the Naumkeag Steam Cotton Mills were calculated in the same manner for comparison, and are given in table 7. In this case, three different controlled temperatures give a better opportunity to develop the curve. The interesting conclusion is reached that lowering the temperature increases the weaving qualities of the yarns.

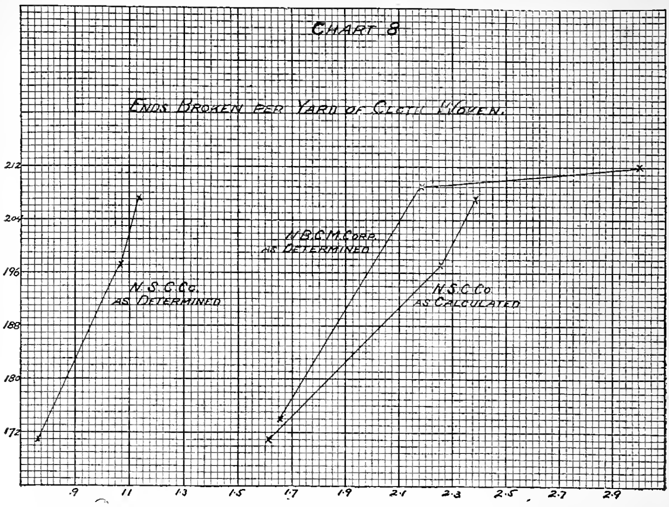


Chart 8. Total Ends Broken per Yard of Cloth. Warps Slashed at the Naumkeag Steam Cotton Company and the New Bedford Cotton Mills Corporation.

Warp	Temperature	Total
1	171° F.	.767
2	197° F.	1.070
3	207° F.	1.130

Table 7. Ends Broken per Linear Yard of Cloth Woven
(Naumkeag Steam Cotton Co.)

There is a considerable higher breakage per yard in results obtained at the New Bedford Cotton Mills Corporation. This is due to a variety of causes. The most important of these are the greater speed of the loom, the higher numbers of the yarn, the width of the cloth, and the density of warp in the goods woven at that mill. Without trying to deduce any hard and fast rule, if we assume that the breakage of yarn is directly proportional to the density of the warp, the numbers of the yarn, the speed of the loom, and to the width of the cloth, we obtain a factor by use of which the instructive comparative figures shown in table 6 were calculated.

$$(156 \div 68) \times (150 \div 104) \times (35 \div 22) \times (36 \div 90) = 2.11$$

Warp	As Determined	As Calculated
1	.767	1.612
2	1.070	2.258
3	1.130	2.384

Table 8. Calculated Breakage per yard
(New Bedford Cotton Mills Corporation.)

These values, along with the corresponding ones for the warps 6 and 7, are shown in graphic form in Chart 9. The curve for the fine warp is just reverse in form of that for the coarse warp. This is due partly to the kind of starch and the nature of sizing compound used. Since each sizing mixture represents the usual practice for mills running on these goods, the results are of direct importance and can be applied without change to concrete problems of sizing. These curves show in a striking manner the value of lower temperatures in size box. They also show that the finer and denser the warp the greater the necessity for this regulation.

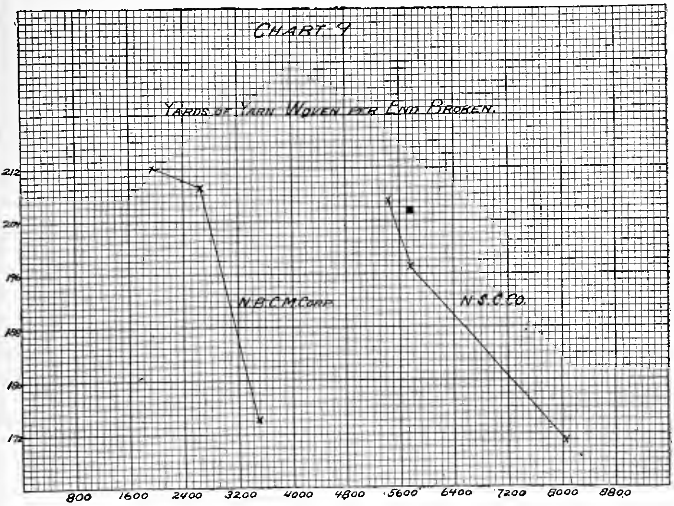


Chart 9. Total Yards of Yarn Woven per End Broken. Warps Slashed at the Naumkeag Steam Cotton Company and the New Bedford Cotton Mills Corporation.

As a check on the calculated per yard basis of comparison the results obtained in the weaving tests were calculated on a basis of the actual number of yards of yarn woven in each warp. This is a better and more direct basis for comparison than that of yards of cloth woven. The results of this calculation were similar to the previous ones, indicating clearly the advantage of lower temperature.

(Naumkeag Steam Cotton Co.)		(New Bedford Cotton Mills Corp.)	
Temperature °F.	Yards	Temperature °F.	Yards
171	8041	174	3505
197	5764	207	2652
207	5458	212	1928

Table 9. Yards of Yarn Woven per End Broken

CONCLUSIONS

Throughout these tests, the results point steadily to the fact that the lower the temperature that the size is applied within the limits tested (171° to 212° F.), the better the results obtained in weaving. The application of this knowledge is not difficult. But when applying, account should be taken of the fact that each size-maker has his own formula. These frequently vary greatly. If the formula gives a very thick mixing, the temperature of the size will have to be kept up to prevent the squeeze rolls from slipping and consequent stopping of the cloth covers of the top roll. Such a thick mixing may be necessary, although it adds to the difficulty in drying to meet particular conditions. Such conditions obtain in practice and they must be recognized and reckoned with. With these things in mind, it is recommended that a temperature as near 170° F. be maintained in the size box as is possible and not run into these difficulties. In the case of slashing warps similar to 1, 2 and 3, I would advise running them at 170° F. For the finer grosgrain warp, I would advise on account of the difficulties above mentioned, 185° F. as the proper temperature.

BREAKING STRENGTH OF SIZED YARNS

The increase in the strength of yarn is, of course, partly determined by the sizing formula, but for any particular formula, the strength of the yarn is increased by increasing the temperature of application within the limits herein set forth. Stronger yarn does not mean increased weaving value but just the reverse. Pliability, not strength, is the factor determining good weaving. This is shown in the following table based on results obtained in a mill making 22's cotton yarn exclusively.

	Temperature in size box.	Ends broken per yard cloth.	Breaking Strength Ozs.	% Gain in Sizing
Unsized Yarn			10.03	
Sized at	171° F.	.77	12.76	27.21
" "	197° F.	1.07	13.19	31.50
" "	207° F.	1.13	13.46	34.19

Roughly speaking, there was an increase of 1% in breaking strength for each 6° the temperature was raised. The difficulty in weaving increased 6.8% for each 6° rise in the temperature.

BREAKING STRENGTH OF CLOTH

6" section, 68 ends per inch, No. 22's yarn.

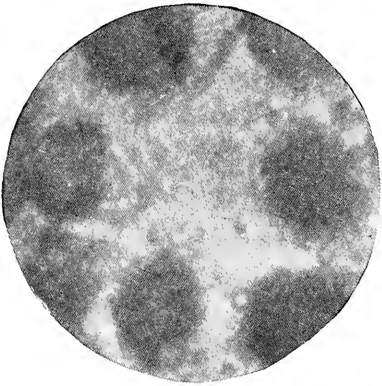
		Cloth Woven	Warp yarn before Weaving
Sized at	171° F.	285 lbs.	326 lbs.
" "	197° F.	280 lbs.	336 lbs.
" "	207° F.	317 lbs.	344 lbs.

Again, the breaking strength of the cloth after weaving cannot be taken as a criterion to judge the value of sizing, as in this case, the cloth made from the best weaving warp breaks at the lowest weight. On the opposite page are shown micro-photographic reproductions of the three cloths used in the above test. The one made on the warp sized at 171° is noticeable for its evenness of interweaving and pliability of yarns.

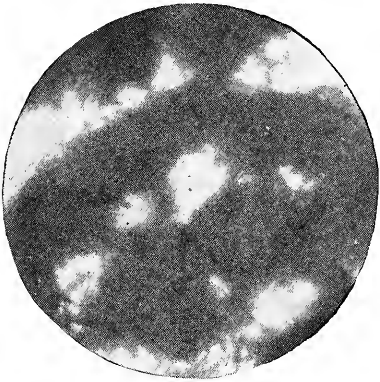
The photographs reproduced on the following pages show the penetration of the starch in sizing. It is very difficult, if not impossible, to decide from these photographs which yarn will weave best.

The dark threads are the warp threads. They have been stained with iodine to show the starch still upon them. It will be seen that the warp is still well coated with starch. In these photographs, the wide variations found in the diameter of the yarns is easily noted. In the photograph of the cloth made from yarn sized at 197°, near the bottom, will be noted a "thin cud," one of the sources of breakage due to "unknown causes."

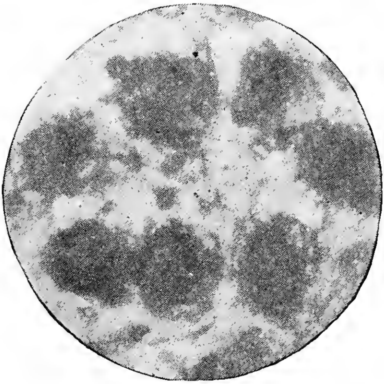
YARNS BEFORE WEAVING



(Best Weaving Yarn)
Sized at 171° F.

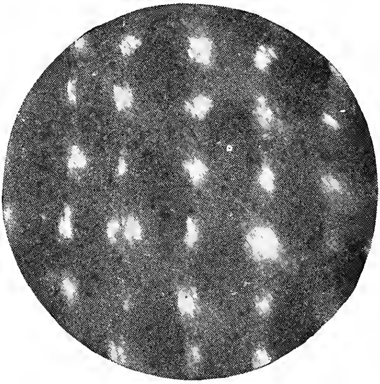


Sized at 197° F.

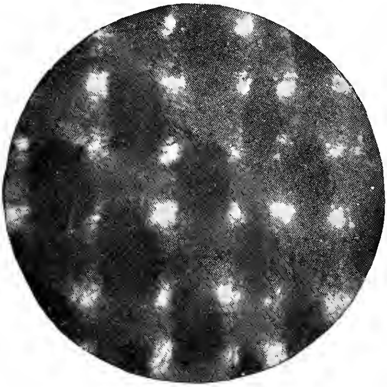


Sized at 207° F.

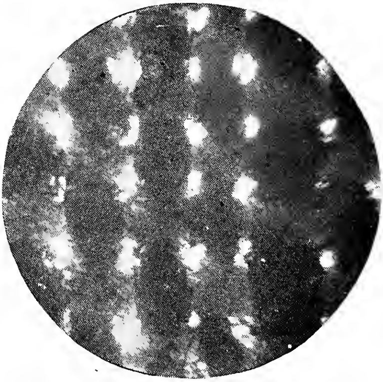
MICRO-PHOTOGRAPHS OF CLOTH WOVEN FROM PRECEDING WARPS



Sized at 171° F.



Sized at 197° F.



Sized at 207° F.

SIZING MATERIALS

Acetic Acid is a colorless or slightly brownish liquid, readily soluble in water. It is usually sold as 8° acid (8° Twaddle) which contains 28% of acid. It is useful in brightening "blueings," "cuttings," and soaps, and acts to make starch paste thinner. It is the only common acid that can be dried on cotton without severe rotting.

Caustic Soda is a hard white solid that rapidly takes water from the air, turning to a liquid if exposed too long. It easily dissolves in water, giving off considerable heat and forming a slippery solution. Its solutions quickly dissolve wool, shrink cotton and mercerize it. It swells starch to a very strong, sticky mass known as "apparatine." Fats boiled in Caustic Soda solutions are made into soaps.

Soda Ash is a white powder, easily dissolved in water and of mild alkaline reaction. It is very useful to neutralize various acids and does not act on cotton except to free it of waxes and impurities. It can be used to make soaps from fats in a manner similar to that of Caustic Soda.

Paraffin Wax is a white solid obtained in the refining of petroleum and does not dissolve in water. It melts at 120° to 130° F. and can be mixed into hot starch pastes at temperatures above these points. From thin pastes it separates on cooling; the thick ones do not. Melted and run into rolls, it is used to make warps weave better. It should not be used in this way on goods that are to be dyed, as it may cause serious stains. The commercial product is very pure.

Tallow is a grayish-white fat usually obtained from the ox or sheep. It is the standard softener used for sizing of yarns. It melts at 110° to 118° F., does not dissolve in water, but melts and forms a partial emulsion. When used with starch, it does not separate. The commercial product varies greatly in purity, always containing water, and frequently starch, salt, and soap. Inferior qualities are made from horses, home fats, and other refuse sources.

Bone Grease is a gray to a brown, soft fat, extracted from the marrow of bones. It has a peculiar, disagreeable odor and melts at 100° to 105° F. It acts much like tallow, giving softer yarns when used for sizing.

Gum Tragasol is a thick, viscous gum obtained from the locust bean. When dry, it is very insoluble in water so it is always sold in paste form. It gives a tough, elastic cover to the yarn, causing it to weave better than if starched. The commercial product is thinned or diluted for use by agitation in water and gentle heating.

Gum Algin is a gum made from sea-weed and comes on the market in the form of the alginate of soda. Its properties are somewhat like gum tragasol. It is used to give adhesiveness to the size mixture.

COOKING OF SIZE

The best way to make a mixing of size is as follows:

1. Measure into your mixing tub or make-up kettle the quantity of water you are to use. (This is best determined by the number of inches in depth in tub).

2. Measure out your starch so as to get exactly the proper weight and add it to the water while constantly stirring.

3. Turn on the steam and raise to 208° to 210° F. in 30 minutes, stirring constantly.

4. Continue heating the starch:

If Corn-Pearl, for 60 minutes;
If Corn, thin boiling for 30 minutes;
If Potato, for 30 minutes;
If Tapioca, for 30 minutes.

5. Shut off steam. The size is now ready for use. If the size starts to thicken, add a little heat to keep from setting.

If the "size" is delivered to a storage tank from the make-up or mixing kettle, the temperature should also be constantly maintained at 170° F. by means of an efficient Automatic Temperature Controller.

The size should flow constantly to the size box of the slasher. In the size box, a constant temperature of from 170° F. to 185° F. should be kept. The proper cooked size would be clear, limp, and show no lumps. Inattention to the time of cooking and the temperatures at which it is cooked are usually the sources of trouble in slashing. Continued cooking of the starch will cause it to grow thin and lose its best sizing qualities. This is particularly noticeable in the cooking of potato starch.

Fortunately, difficulties of this nature are no longer necessary because specially designed devices manufactured by the C. J. Tagliabue Mfg. Co., will automatically take care of the cooking. For instance, the "TAG" Automatic Combination Time and Temperature Controller will regulate the time that is required to raise the temperature to a boil, also the exact time that the "size" mixture is to be boiled, without any attention from the slasher-tender. Likewise, in the size box, the temperature of the size is easily maintained by means of the "TAG" Self-Operating Size Box Controller. Slasher rooms equipped with these simple but efficient devices need have little fear of uneven sizing or soft warps.

TABLES SHOWING CAPACITIES OF THE STANDARD SIZES OF KETTLES AT DIFFERENT DEPTHS

32″ Diam.
32″ Deep.

1″	3.5	gals.
2″	7.0	“
3″	10.5	“
4″	14.0	“
5″	17.5	“
6″	21.0	“
7″	24.5	“
8″	28.0	“
9″	31.5	“
10″	35.0	“
20″	70.0	“
30″	105.0	“
32″	112.0	“

33″ Diam.
42″ Deep.

1″	3.7	gals.
2″	7.4	“
3″	11.1	“
4″	14.8	“
5″	18.5	“
6″	22.2	“
7″	25.9	“
8″	29.6	“
9″	33.3	“
10″	37.0	“
20″	74.0	“
30″	111.0	“
40″	148.0	“

36″ Diam.
36″ Deep.

1″	4.4	gals.
2″	8.8	“
3″	13.2	“
4″	17.6	“
5″	22.0	“
6″	26.4	“
7″	30.8	“
8″	35.2	“
9″	39.6	“
10″	44.0	“
20″	88.0	“
30″	132.0	“
36″	158.0	“

42″ Diam.
42″ Deep.

1″	6.0	gals.
2″	12.0	“
3″	18.0	“
4″	24.0	“
5″	30.0	“
6″	36.0	“
7″	42.0	“
8″	48.0	“
9″	54.0	“
10″	60.0	“
20″	120.0	“
30″	180.0	“
40″	240.0	“
42″	252.0	“

48″ Diam.
48″ Deep.

1″	7.8	gals.
2″	15.6	“
3″	23.4	“
4″	31.2	“
5″	39.0	“
6″	46.8	“
7″	54.6	“
8″	62.4	“
9″	70.2	“
10″	78.0	“
20″	156.0	“
30″	234.0	“
40″	312.0	“
48″	374.4	“

FORMULA

Starch ....lbs.

Other Substances
....lbs.
....lbs.
....lbs.

Water.. inches ....gals.

Method of cooking..

....

Yarn sized..

....

FORMULA

Starch ....lbs.

Other Substances
....lbs.
....lbs.
....lbs.

Water.. inches ....gals.

Method of cooking..

....

Yarn sized..

....

FORMULA

Starch ....lbs.

Other Substances
....lbs.
....lbs.
....lbs.

Water.. inches ....gals.

Method of cooking..

....

Yarn sized..

....

FORMULA

Starch .... lbs.

Other Substances
.... lbs.
.... lbs.
.... lbs.

Water .... inches .... gals.

Method of cooking ....

....

Yarn sized ....

....

FORMULA

Starch .... lbs.

Other Substances
.... lbs.
.... lbs.
.... lbs.

Water .... inches .... gals.

Method of cooking ....

....

Yarn sized ....

....

FORMULA

Starch .... lbs.

Other Substances
.... lbs.
.... lbs.
.... lbs.

Water .... inches .... gals.

Method of cooking ....

....

Yarn sized ....

....

To Calculate Counts of Cotton Yarn.

Measure off 120 yards of the yarn and weigh in grains. Multiply the grains by 7, divide the answer into (7000) and then your answer will be the counts of the yarn.

Example:

120 yards weighs 50 grains, find the counts of yarn:

$$\frac{7000}{50 \times 7} = 20\text{'s yarn.}$$

To Calculate Counts of Worsted Yarn.

Measure off 80 yards of the yarn and find its weight in grains. Multiply the grains by 7, divide into (7000) and then your answer will be the counts of worsted yarn.

Example:

80 yards weigh 100 grains, find the counts of yarn:

$$\frac{7000}{100 \times 7} = 10\text{'s worsted yarn.}$$

To Calculate Counts of Spun Silk.

(Use the same method as you would use for Cotton.)

Measure 120 in grains, multiply the grains by 7 and divide the answer into (7000). The answer will be the counts of spun silk.

To Calculate Counts of (Tram or Gum) Silk. (English).

Measure off 100 yards of the yarn in grains, multiply the grains by 70 and divide result into (7000). The answer will be the counts of the silk.

Example:

100 yards of (Tram or Gum) silk weighs 2 grains, what is the count of the yarn?

$$\frac{7000}{2 \times 70} = 50\text{'s silk yarn.}$$

To Calculate Counts of Artificial Silk.

Use the same method as for Cotton and Spun Silk.

120 yards weighed into grains, the result multiplied by 7 and this divided into (7000). The answer will give you the counts of artificial silk.

BASIS OF THE COUNT SYSTEMS OF YARNS.
Standard Length

System	Length Unit	Weight Unit	Yds. per Lb. of No. 1
Cotton, English..........	840 yds.	1 lb.	840
Cotton, French..........	1,000 metres	500 grms.	992.12
Linen....................	300 yds.	1 lb.	300
Worsted................	560 yds.	1 lb.	560
Wool, French...........	100 metres	1,000 grms.	496

$$\frac{\dfrac{\text{Length of yarn in yards}}{\text{Length Unit}}}{\dfrac{\text{Weight of yarn in lbs.}}{\text{Weight Unit}}} = \text{Number of yarn (or counts).}$$

For example, if 120 yards of cotton yarn weigh 1 oz. = 1/16 lb., its number (or count) is:

$$\frac{\dfrac{120}{8407}}{\dfrac{\frac{1}{16}}{1}} = \frac{\dfrac{1}{7}}{\dfrac{1}{16}} = \frac{16}{7} = 2\ 2/7 \text{ counts.}$$

For other determinations, for example, worsted, select from the table the proper units for length and weight as used in exactly the same formula. The great advantage of the above table is that counts can be determined from any weight or length of yarn.

1. To find the length of Cotton Yarn on a Slasher Beam when the weight of the yarn, counts, and number of ends are known:

Multiply the weight of yarn on the beam by the counts, and by 840, divide the result by the number of ends and then the result will be the length of the cotton yarn on the beam.

Example:

A beam contains 500 ends of number 22's cotton yarn weighing 250 pounds. Find the length of the yarn?

$$\frac{250 \times 22 \times 840}{500} = 9240 \text{ yards.}$$

2. To find the length of yarn to run onto a loom beam in order to make a certain number of cuts of a certain length of cloth to the cut:

Multiply the number of cuts by the number of yards of cloth to be woven to the cut, and then by 1.00 + the percentage allowed for contraction in weaving (which is around 8% in plain cloth) and the answer is the length of the yarn you are required to run onto the beam in order to make the number of cuts of required yardage.

Example:

A loom beam is to be made containing 10 cuts of 40 yards each, allowing 8% to be used in weaving, how much yarn must be run on?

$1.00 + .08 = 1.08$
$1.08 \times 40 \times 10 = 432$ yards of yarn to be run on.

3. To find the number of loom beams you can make from a certain length of yarn on a slasher beam:

Divide the length of yarn on the slasher beam by the length required on the loom beam. The result will be the number of loom beams you can make from the slasher beam.

Example:

Find out how many loom beams you can make from a slasher beam containing yarn 9240 yards in length, the loom beams to be made requiring 432 yards of yarn in length:

$\frac{9240}{432}$ = 21 loom beams of required length of yarn, leaving 168 yards of yarn on the slasher beam.

In this case, they would usually run 18 beams containing 10 cuts each and 3 containing 11 cuts, and run the rest of the yarn which would not quite be a cut, on the last beam.

TABLE OF MULTIPLES.

Centimeters × 0.3937 = inches.
Centimeters × 0.0328 = feet.
Centimeters, cubic × 0.0338 = apothecaries' fluid ounces.
Diameter of a circle × 3.1416 = circumference.
Gallons × 3.785 = liters.
Gallons × 0.833565 = imperial gallons.
Gallons, imperial × 1.199666 = U. S. gallons.
Gallons × 8.33505 = pounds of water.
Gallons, imperial × 10 = pounds of water.
Gallons, imperial × 4.54102 = liters.
Grains × 0.0648 = grams.
Inches × 0.0254 = meters.
Inches × 25.4 = millimeters.
Miles × 1.609 = kilometers.
Ounces, Troy × 1.097 = ounces of avoirdupois.
Ounces, Avoirdupois × 0.9115 = ounces Troy.
Pounds, Avoirdupois × 0.4536 = kilograms.
Pounds, Avoirdupois × 0.8228572 = pounds Troy.
Pounds, Troy × 0.37286 = kilograms.
Pounds, Troy × 1.21527 = pounds Avoirdupois.
Radius of a circle × 6.283185 = circumference.
Square of the radius × 3.1416 = area.
Square of the circumference of a circle × 0.07958 = area.

MISCELLANEOUS MEASURES.

Barrel of flour = 196 pounds.
Barrel of salt = 280 pounds.
Bale of cotton = (in America) 400 pounds.
Bale of cotton = (in Egypt) 90 pounds.
Bag of Sea Island cotton = 300 pounds.
Cable = 120 fathoms.
Can = 35 pounds.
Cask of lime = 240 pounds.
Fathom = 6 feet.
Hand = 4 inches.
Hogshead = 63 gallons.
Keg (nails) = 100 pounds.
Noggin or Nog. = 5/16 of a pint.
Pace = 3.3 feet.
Palm = 3 inches.
Pipe = 2 hogsheads.
Stone = 14 pounds.
Tun = 2 pipes.
Cubic foot of water weighs 62.4 pounds.
Cubic foot of water is 7.48 gallons.
Gallon of water weighs 8 1/3 pounds.
Gallon of water is 231 cubic inches.
In England, wool is sold by the sack, or boll, of 22 stones, which, at 14 pounds to the stone, is 308 pounds.
A pack of wool is 17 stones and 2 pounds, which is rated as a pack load for a horse. It is 240 pounds.
Sack of flour = 280 pounds.
A tod of wool is 2 stones of 14 pounds, or 28 pounds.
A wey of wool is 6¼ tods, or 175 pounds.
Two weys, a sack, or 350 pounds.
A clove of wool is half a stone, or 7 pounds.
Mile = 5,280 feet or 1,609.3 meters.
Millier or tonneau = 2,204.6 pounds.
Milligram = 0.0154 grain.
Millimeter (1/1000 meter) = 0.0394 inch.
Myriagram = 22.046 pounds.
Myriameter (10,000 meters) = 6.2137 miles.
Ounce (Avoirdupois) = 28.350 grains.
Ounce (Troy or Apothecaries) = 31.104 grams.
Ounce (fluid) = 28.3966 cubic centimeters.
Peck = 9.08 liters.
Pint (liquid) = 0.47318 liter.
Pound (Avoirdupois) = 453.603 grams.
Pound (English) = 0.453 kilogram.
Pound (Troy) = 373.25 grams.
Quart (liquid) = 0.94636 liter.
Quintal = 220.46 pounds.
Scruple (Troy) = 1.296008 grams.
Ton = 20 hundredweight = 2,240 pounds (Avoirdupois) 1,016.070 kilograms.
Yard = 0.9144 meter.

COMPARISON OF METRIC SYSTEM WITH THE UNITED STATES METHOD OF WEIGHTS AND MEASURES.

(Arranged in Alphabetical Order).

Are (100 square meters) = 119.6 square yards.
Bushel = 2150.42 cubic inches, 35.24 liters.
Centare (1 square meter) = 1550 square inches.
Centigram (1/100 gram) = 0.1543 grain.
Centiliter (1/100 liter) = 2.71 fluid drams, 0.338 fluid ounces.
Centimeter (1/100 meter) = 0.3937 inch.
1 Cubic Centimeter = 16.23 minims (Apothecaries).
10 Cubic Centimeters = 2.71 fluid drams (Apothecaries).
30 Cubic Centimeters = 1.01 fluid ounces (Apothecaries).
100 Cubic Centimeters = 3.38 fluid ounces (Apothecaries).
473 Cubic Centimeters = 16.00 fluid ounces (Apothecaries).
500 Cubic Centimeters = 16.90 fluid ounces (Apothecaries).
1000 Cubic Centimeters = 33.81 fluid ounces (Apothecaries).
Decigram (1/10 gram) = 1 5432 grains.
Decimeter (1/10 meter) = 3 937 inches.
Deciliter (1/10 liter) = 0.845 gill.
Dekagram (10 grams) = 0.3527 ounce.
Dekaliter (10 liters) = 9.08 quarts (dry), 2.6418 gallons.
Dekameter (10 meters) = 393.7 inches.
Dram (Apothecaries cr Troy) = 3 9 grams.
Foot = 0.3048 meter, or 30.48 centimeters.
Gallon = 3.785 liters.
Gill = 0.118295 liter, or 142 cubic centimeters.
Grain (Troy) = 0.064804 gram.
Grain = 0.0648.
Gram = 15.432 grains.
Hectare (10,000 square meters) = 2.471
Hectogram = 3 5274 ounces.
Hectoliter (100 liters) = 2.838 bushels, or 26.418 gallons.
Hectometer (100 meters) = 328 feet 1 inch.
Hundredweight (112 pounds Avoirdupois) = 50.8 kilograms.
Inch = 0.0254 meter.
Inch = 2.54 centimeters.
Inch = 25.40 millimeters.
Kilogram = 2 2046 pounds, or 35.274 ounces.
Kiloliter (1,000 liters) = 1.308 cubic yards, or 264.18 gallons.
Kilometer (1,000 meters) = 0.62137 miles (3.280 feet 10 inches).
Liter = 1.0567 quarts, 0.264 gallon (liquid), or 0.908 quart (dry).
Meter = 39.3700 inches, or 3.28083 feet.
Mile = 1.609 kilometers.

PRODUCTION TABLE FOR SLASHER HAVING 7 FT. AND 5 FT. CYLINDERS—Pounds per 10 Hours

No. of Yarn	Number of Ends in Warp											No. of Yarn
	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	
8	2214	2318	2409	2489	2555	2610	2659	2703	2743	2778	2808	8
10	2022	2098	2166	2217	2388	2456	2514	2562	2601	2631	2657	10
12	1796	1896	1987	2071	2147	2216	2277	2330	2375	2412	2442	12
14	1631	1725	1813	1894	1969	2036	2098	2156	2205	2248	2285	14
16	1502	1592	1676	1756	1830	1898	1962	2018	2071	2118	2159	16
18	1398	1485	1567	1644	1716	1786	1847	1906	1960	2009	2054	18
20	1312	1395	1475	1550	1653	1688	1752	1811	1866	1917	1964	20
22	1238	1319	1396	1469	1539	1606	1669	1728	1784	1836	1885	22
24	1174	1252	1327	1399	1467	1533	1595	1655	1711	1764	1814	24
26	1117	1193	1265	1335	1403	1467	1529	1588	1645	1698	1749	26
28	1066	1139	1210	1279	1344	1408	1469	1528	1584	1638	1690	28
30	1020	1091	1159	1226	1291	1353	1413	1471	1528	1582	1634	30
32	977	1046	1113	1178	1241	1303	1362	1420	1475	1529	1581	32
34	937	1004	1069	1133	1195	1242	1314	1370	1425	1479	1536	34
36		965	1029	1091	1151	1210	1268	1324	1378	1431	1482	36
38			990	1051	1110	1168	1224	1279	1333	1385	1436	38
40				1012	1070	1127	1182	1236	1289	1341	1392	40
42					1032	1088	1142	1195	1247	1298	1348	42
44						1050	1103	1155	1207	1257	1306	44
46							1065	1117	1167	1216	1265	46
48								1070	1128	1177	1225	48
50									1090	1138	1181	50
60										956	998	60

No. of Yarn	Number of Ends in Warp											No. of Yarn
	2300	2400	2500	2600	2700	2800	2900	3000	3100	3200	3300	
8	2832	2847	2860									8
10	2680	2701	2717	2731								10
12	2466	2484	2498	2507	2517							12
14	2315	2338	2362	2382	2395	2405						14
16	2195	2225	2250	2270	2285	2293	2297					16
18	2094	2130	2161	2187	2209	2226	2238	2245				18
20	2008	2047	2082	2113	2140	2164	2183	2198	2209			20
22	1931	1980	2006	2049	2076	2106	2130	2151	2168	2182		22
24	1861	1905	1946	1984	2019	2051	2079	2105	2127	2147	2163	24
26	1798	1843	1886	1926	1964	1998	2030	2052	2086	2110	2131	26
28	1739	1785	1830	1871	1911	1948	1983	2015	2045	2072	2097	28
30	1683	1731	1776	1819	1860	1899	1936	1970	2003	2032	2058	30
32	1631	1678	1725	1769	1811	1851	1890	1926	1961	1994	2045	32
34	1580	1632	1675	1720	1757	1805	1845	1883	1919	1954	1992	34
36	1532	1581	1628	1673	1717	1759	1800	1839	1877	1913	1948	36
38	1485	1534	1576	1627	1671	1714	1755	1796	1834	1872	1908	38
40	1441	1489	1536	1582	1626	1669	1711	1752	1792	1830	1868	40
42	1397	1445	1491	1537	1582	1625	1668	1709	1750	1789	1827	42
44	1354	1402	1448	1494	1538	1582	1625	1662	1707	1748	1786	44
46	1313	1360	1406	1451	1495	1539	1582	1628	1664	1705	1744	46
48	1272	1318	1364	1409	1453	1496	1539	1580	1622	1662	1702	48
50	1231	1277	1314	1367	1410	1454	1496	1537	1579	1620	1659	50
60	1041	1083	1124	1166	1207	1247	1288	1328	1368	1408	1447	60

COMPARATIVE TEMPERATURE AND PRESSURE TABLE

(Fahrenheit and Centigrade)

F.	C.	F.	C.	F.	C.	F.	C.
32.	0.	64.40	18.	97.25	36.25	129.20	54.
33.	0.56	65.	18.34	98.	36.67	130.	54.45
33.80	1.	65.75	18.75	98.60	37.	131.	55.
34.	1.11	66.	18.89	99.	37.23	132.	55.56
34.25	1.25	66.20	19.	99.50	37.50	132.80	56.
35.	1.67	67.	19.45	100.	37.78	133.	56.11
35.60	2.	68.	20.	100.40	38.	133.25	56.25
36.	2.23	69.	20.56	101.	38.34	134.	56.67
36.50	2.50	69.80	21.	101.75	38.75	134.60	57.
37.	2.78	70.	21.11	102.	38.89	135.	57.23
37.40	3.	70.25	21.25	102.20	39.	135.50	57.50
38.	3.34	71.	21.67	103.	39.45	136.	57.78
38.75	3.75	71.60	22.	104.	40.	136.40	58.
39.	3.89	72.	22.23	105.	40.56	137.	58.34
39.20	4.	72.50	22.50	105.80	41.	137.75	58.75
40.	4.45	73.	22.78	106.	41.11	138.	58.89
41.	5.	73.40	23.	106.25	41.25	138.20	59.
42.	5.56	74.	23.34	107.	41.67	139.	59.45
42.80	6.	74.75	23.75	107.60	42.	140.	60.
43.	6.11	75.	23.89	108.	42.23	141.	60.56
43.25	6.25	75.20	24.	108.50	42.50	141.80	61.
44.	6.67	76.	24.45	109.	42.78	142.	61.11
44.60	7.	77.	25.	109.40	43.	142.25	61.25
45.	7.23	78.	25.56	110.	43.34	143.	61.67
45.50	7.50	78.80	26.	110.75	43.75	143.60	62.
46.	7.78	79.	26.11	111.	43.89	144.	62.23
46.40	8.	79.25	26.25	111.20	44.	144.50	62.50
47.	8.34	80.	26.67	112.	44.45	145.	62.78
47.75	8.75	80.60	27.	113.	45.	145.40	63.
48.	8.89	81.	27.23	114.	45.56	146.	63.34
48.20	9.	81.50	27.50	114.80	46.	146.75	63.75
49.	9.45	82.	27.78	115.	46.11	147.	63.89
50.	10.	82.40	28.	115.25	46.25	147.20	64.
51.	10.56	83.	28.34	116.	46.67	148.	64.45
51.80	11.	83.75	28.75	116.60	47.	149.	65.
52.	11.11	84.	28.89	117.	47.23	150.	65.56
52.25	11.25	84.20	29.00	117.50	47.50	150.80	66.
53.	11.67	85.	29.45	118.	47.78	151.	66.11
53.60	12.	86.	30.	118.40	48.	151.25	66.25
54.	12.23	87.	30.56	119.	48.34	152.	66.67
54.50	12.50	87.80	31.	119.75	48.75	152.60	67.
55.	12.78	88.	31.11	120.	48.89	153.	67.23
55.40	13.	88.25	31.25	120.20	49.	153.50	67.50
56.	13.34	89.	31.67	121.	49.45	154.	67.78
56.75	13.75	89.60	32.	122.	50.	154.40	68.
57.	13.89	90.	32.23	123.	50.56	155.	68.34
57.20	14.	90.50	32.50	123.80	51.	155.75	68.75
58.	14.45	91.	32.78	124.	51.11	156.	68.89
59.	15.	91.40	33.	124.25	51.25	156.20	69.
60.	15.56	92.	33.34	125.	51.67	157.	69.45
60.80	16.	92.75	33.75	125.60	52.	158.	70.
61.	16.11	93.	33.89	126.	52.23	159.	70.56
61.25	16.25	93.20	34.	126.50	52.50	159.80	71.
62.	16.67	94.	34.45	127.	52.78	160.	71.11
62.60	17.	95.	35.	127.40	53.	160.25	71.25
63.	17.23	96.	35.56	128.	53.34	161.	71.67
63.50	17.50	96.80	36.	128.75	53.75	161.60	72.
64.	17.78	97.	36.11	129.	53.89	162.	72.23

Fahrenheit	Centigrade	Gauge Pressure lbs.	Fahrenheit	Centigrade	Gauge Pressure lbs.
162.50	72.50		197.	91.67	
163.	72.78		197.60	92.	
163.40	73.		198.	92.23	
164.	73.34		198.50	92.50	
164.75	73.75		199.	92.78	
165.	73.89		199.40	93.00	
165.20	74.		200.	93.34	
166.	74.45		200.75	93.75	
167.	75.		201.	93.89	
168.	75.56		201.20	94.	
168.80	76.		202.	94.45	
169.	76.11		203.	95.	
169.25	76.27		204.	95.56	
170.	76.67		204.80	96.	
170.60	77.		205.	96.11	
171.	77.23		205.25	96.25	
171.50	77.50		206.	96.67	
172.	77.78		206.60	97.	
172.40	78.		207.	97.23	
173.	78.34		207.50	97.50	
173.75	78.75		208.	97.78	
174.	78.89		208.40	98.	
174.20	79.		209.	98.34	
175.	79.45		209.75	98.75	
176.	80.		210.	98.89	
177.	80.56		210.20	99.	
177.80	81.		211.	99.45	
178.	81.11		212.	100.	0
178.25	81.25		213.	100.56	
179.	81.67		213.80	101.	
179.60	82.		214.	101.11	
180.	82.23		214.25	101.25	
180.50	82.50		215.	101.67	1
181.	82.78		215.60	102.	
181.40	83.		216.	102.23	
182.	83.34		216.50	102.50	
182.75	83.75		217.	102.78	
183.	83.89		217.40	103.	
183.20	84.		218.	103.34	
184.	84.45		218.75	103.75	
185.	85.		219.	103.89	2
186.	85.56		219.20	104.	
186.80	86.		220.	104.45	
187.	86.11		221.	105.	
187.25	86.25		222.	105.56	3
188.	86.67		222.80	106.	
188.60	87.		223.	106.11	
189.	87.23		223.25	106.25	
189.50	87.50		224.	106.67	4
190.	87.78		224.60	107.	
190.40	88.		225.	107.23	
191.	88.34		225.50	107.50	
191.75	88.75		226.	107.78	
192.	88.89		226.40	108.	
192.20	89.		227.	108.34	5
193.	89.45		227.75	108.75	
194.	90.		228.	108.89	
195.	90.56		228.20	109.	
195.80	91.		229.	109.45	
196.	91.11		230.	110.	6
196.25	91.25		231.	110.56	

Fahrenheit	Centigrade	Gauge Pressure lbs.	Fahrenheit	Centigrade	Gauge Pressure lbs.
231.80	111.		266.	130.	
232.	111.11	7	267.	130.56	25
232.25	111.25		267.80	131.	
233.	111.67		268.	131.11	26
233.60	112.		268.25	131.25	
234.	112.23		269.	131.67	
234.50	112.50		269.60	132.	
235.	112.78	8	270.	132.23	27
235.40	113.		270.50	132.50	
236.	113.34		271.	132.78	28
236.75	113.75		271.40	133.	
237.	113.89	9	272.	133.34	
237.20	114.		272.75	133.75	
238.	114.45		273.	133.89	29
239.	115.	10	273.20	134.	
240.	115.56		274.	134.45	30
240.80	116.		275.	135.	31
241.	116.11		276.	135.56	
241.25	116.25		276.80	136.	
242.	116.67	11	277.	136.11	32
242.60	117.		277.25	136.25	
243.	117.23		278.	136.67	33
243.50	117.50		278.60	137.	
244.	117.78	12	279.	137.23	34
244.40	118.		279.50	137.50	
245.	118.34		280.	137.78	
245.75	118.75		280.40	138.	
246.	118.89	13	281.	138.34	35
246.20	119.		281.75	138.75	
247.	119.45		282.	138.89	36
248.	120.	14	282.20	139.	
249.	120.56		283.	139.45	37
249.80	121.		284.	140.	38
250.	121.11	15	285.	140.56	
250.25	121.25		285.80	141.	
251.	121.67		286.	141.11	39
251.60	122.		286.25	141.25	
252.	122.23	16	287.	141.67	40
252.50	122.50		287.60	142.	
253.	122.78		288.	142.23	41
253.40	123.		288.50	142.50	
254.	123.34	17	289.	142.78	42
254.75	123.75		289.40	143.	
255.	123.89	18	290.	143.34	43
255.20	124.		290.75	143.75	
256.	124.45		291.	143.89	44
257.	125.	19	291.20	144.	
258.	125.56		292.	144.45	45
258.80	126.		293.	145.	
259.	126.11	20	294.	145.56	46
259.25	126.25		294.80	146.	
260.	126.67		295.	146.11	47
260.60	127.		295.25	146.25	
261.	127.23	21	296.	146.67	48
261.50	127.50		296.60	147.	
262.	127.78	22	297.	146.23	49
262.40	128.		297.50	147.50	
263.	128.34		298.	147.78	50
263.75	128.75		298.40	148.	
264.	128.89	23	299.	148.34	51
264.20	129.		299.75	148.75	
265.	129.45	24	300.	148.89	52

HOW TO USE A HYDROMETER

The hydrometer must be absolutely clean, to begin with, and should therefore be wiped thoroughly with a clean, soft rag before using. The jar or other receptacle should also be deep enough to allow the hydrometer to float freely—without touching the bottom.

Insert the hydrometer by grasping same at the extreme end and above the scale portion (so that the indications will not be affected by moisture or grease on the stem from the hand) and be careful to let it sink of its own weight only. After the hydrometer has come to rest, carefully push it into the liquid to the extent of 1/16 inch further and allow it to again come to rest; this procedure being for the purpose of facilitating the forming of the proper meniscus around the stem of the hydrometer by the solution.

Then note the point on the scale which corresponds exactly with the level of the surface of the solution and do *not* use the top of the meniscus as the proper point.

In the case of a transparent solution, it is easy to get the exact point by the following method: First observe the liquid within the jar or other receptacle from below the level of the solution so that the "mirror," caused by the light reflection of the top surface, is distinctly visible; then raise the eye slowly and observe how this mirror gradually disappears as the eye travels upward; just when the mirror is finally lost will then leave the eye exactly in the plane with the top of the surface and in position to take the exact reading.

When the solution is opaque, however, the extent of the meniscus must be carefully measured with the eye and subtracted from the reading given by the top of the meniscus, so that the true reading given by the level of the main body of the solution is obtained.

When the hydrometer is of combination form, the temperature indicated by the thermometer portion is next noted so that the necessary correction can be applied if the solution varies in temperature from that at which the hydrometer was standardized.

The correction, however, being so small, is entirely negligible and can be disregarded. A hydrometer for testing size would be standardized at 150° F.

Therefore the temperature reading of the solution is not taken until the thermometer has had ample time to register approximately 150° F.

In the case of a plain hydrometer (without thermometer combined with the instrument) the temperature of the solution must be ascertained with a separate thermometer. Of course, the hydrometer reading should not be taken until the thermometer registers 150° F.

DENSITY TABLE

Specific Gravity	Degrees Baume	Degrees Twaddell	Lbs. per Gallon	Lbs. per Cu. Ft.
1.00	0	0	8.35	62.43
1.01	1.4	2	8.43	63.02
1.02	2.7	4	8.51	63.68
1.03	4.1	6	8.60	64.27
1.04	5.4	8	8.68	64.92
1.05	6.7	10	8.77	65.52
1.06	8.0	12	8.85	66.17
1.07	9.4	14	8.93	66.77
1.08	10.6	16	9.01	67.42
1.09	11.9	18	9.10	68.02
1.10	13.0	20	9.18	68.67
1.11	14.2	22	9.27	69.26
1.12	15.4	24	9.35	69.92
1.13	16.5	26	9.44	70.51
1.14	17.7	28	9.51	71.17
1.15	18.8	30	9.60	71.76
1.16	19.8	32	9.68	72.41
1.17	20.9	34	9.77	73.01
1.18	22.0	36	9.85	73.66
1.19	23.0	38	9.94	74.26
1.20	24.0	40	10.01	74.91
1.21	25.0	42	10.10	75.50
1.22	26.0	44	10.18	76.16
1.23	26.9	46	10.27	76.75
1.24	27.9	48	10.35	77.41

WHAT IS TEMPERATURE?

WHAT IS HEAT?

Temperature.

If we touch a body and it feels hot, we are accustomed to say that it has a high temperature, likewise, if the body feels cold, we are accustomed to say that its temperature is low. Thus, the sensations experienced upon touching a substance, gives a general idea of the state of temperature of the substance, and the terms hot, warm, temperate, chilly, and cold are used to indicate the amount of temperature.

These terms, however, give only a general idea of the temperature. If the hand is held in cold water for a while and is then placed quickly in warm water, the warm water will feel much warmer than it actually is. If a small quantity of gasoline which has been in a room until it has attained room temperature, is poured on the hand, it seems much cooler than it actually is.

It can readily be seen from these facts that the sensations of hot and cold cannot be depended upon in judging temperature, and it is therefore necessary to adopt some other means of measuring this quantity where it is desired to obtain more accurate results.

It should be noted that the temperature does not indicate the amount of heat which a substance contains but only shows the condition of the heat in the substance. If one vessel contains a pint of water at a certain temperature and another contains a quart of water at the same temperature, the quart of water has absorbed more heat than the pint has and, consequently it contains more heat although its temperature is the same as the pint of water.

Thermometers.

A thermometer is an instrument for measuring temperature. Therometers indicate the intensity of the temperature by the expansion of mercury or colored spirit. The ordinary mercury thermometer is so familiar that it scarcely needs a description.

In the Fahrenheit thermometer, which is generally used in the United States, the point at which the mercury stands in the tube when the instrument is placed in melting ice, is marked thirty-two degrees. The point indicated by the mercury when the thermometer is placed in the steam arising from boiling water, under atmospheric pressure and at sea level, is marked 212° F. The tube between these two points is divided into 180 equal parts called degrees.

On the Centigrade thermometer, the distance between these two points is divided into 100 equal parts called degrees, the freezing point being zero and the boiling point 100°. The following rules have been obtained for converting one into the other:

Rule No. 1.—To convert degrees Fahrenheit to degrees Centigrade, subtract 32, multiply the remainder by 5 and divide by 9.

Rule No. 2.—To convert degrees Centigrade to degrees Fahrenheit, multiply by 9, divide by 5 and add 32.

Heat.

Modern science teaches that heat is a form of energy and that all matter is composed of molecules which are more or less in a state of rapid vibration. The rapidity or intensity of these vibrations produces the sensations of warmth or cold. From this it will be seen that cold is a relative expression and signifies a greater or less absence of heat or motion of the molecules of a body. If the motion of the molecules is rapid, the body is warm; if their motion is slow, the body is less warm or cold.

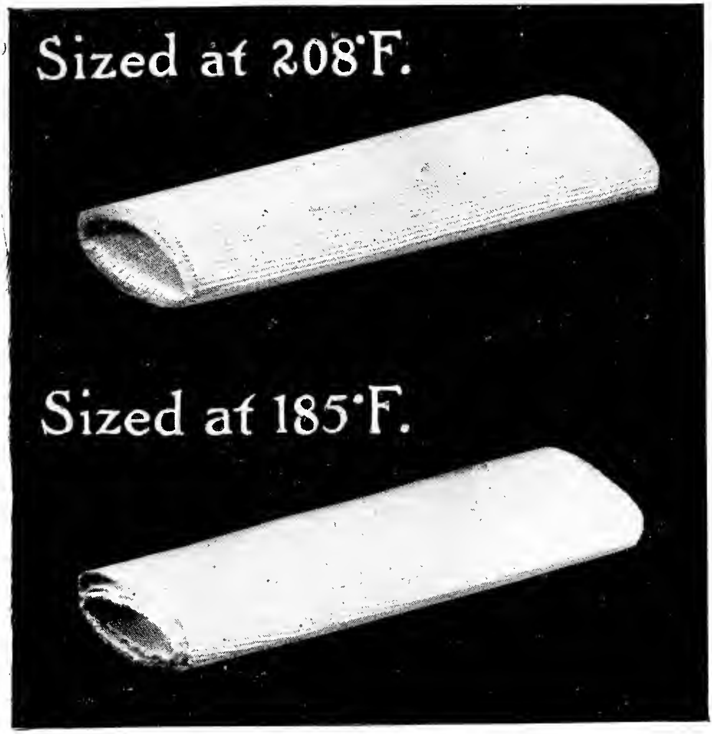
Measurement of Heat.

Since heat is not a substance and has no weight, it cannot be determined by a measure of volume or by weight, but can only be measured by the effect it produces on other substances. The quantity of heat required to raise the temperature of one pound of water one degree, at or near its temperature at maximum density, (39 1/10° F.), has been selected as the standard unit of measure and is called the British Thermal Unit, commonly abbreviated B. T. U.

A SIMPLE SIZED YARN TEST!

Take a warp thread after it has left the drying cylinder and hold it between your thumb and first finger as shown in the above illustration. Have four inches of the yarn above the fingers and if the thread has *sufficient strength* to maintain an upright position, you will know that the yarn has been *properly* sized.

However, if your sized yarn will not stand this simple test, it is very likely that the trouble is due to *fluctuating* temperatures within the size mixing or cooking kettles and in the size boxes. *"TAG" Size Box Automatic Temperature Controllers offer a simple and self-paying solution.*



NOTE THE DIFFERENCE IN "FEEL" AND "COVER"

This illustration is a photographic reproduction of two pieces of cloth (woven at the same mill) before they were boiled out, scoured or bleached. The "size" mixture, yarn, etc., were identical *except* that each piece of cloth was sized at the temperature indicated.

Note the difference in texture—how much softer and more uniform in appearance the texture is where the warp had been sized at a lower temperature and *uniformly maintained* at 185° F. by having the size boxes equipped with "TAG" Size Box Automatic Temperature Controllers.

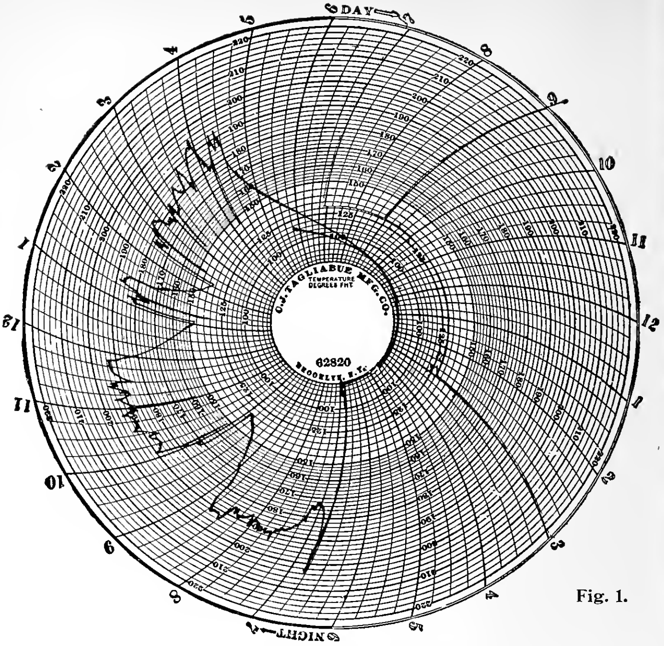


Fig. 1.

These two charts are records of the temperature of the size maintained in a size box under *identical* operating conditions, the temperature desired being 200° F. Fig. 1, shows the irregularity and fluctuations produced by the *most careful* ***HAND CONTROL*** and Fig. 2, the *uniformity* produced by a "TAG" AUTOMATIC TEMPERATURE CONTROLLER. (*These results were obtained at the mills of the York Mfg. Co.*)

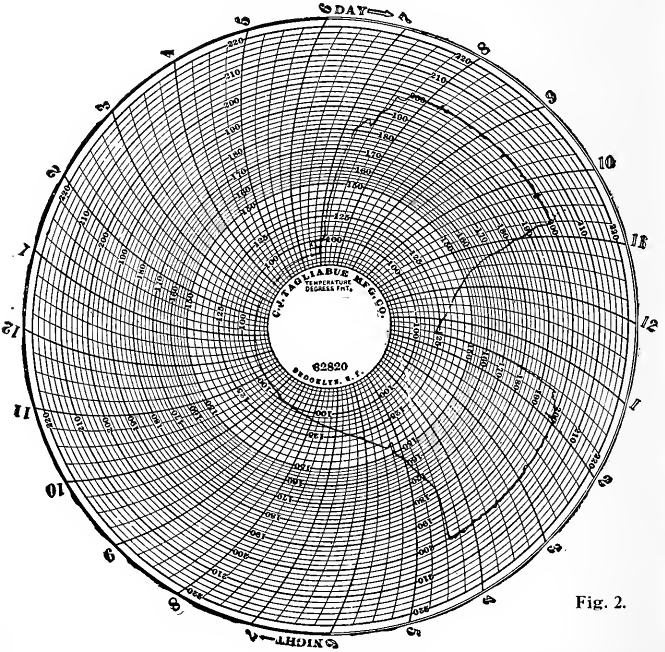


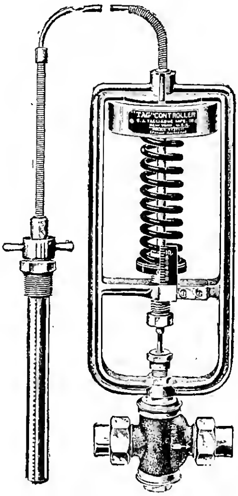
Fig. 2.

"TAG" Self-Operating SIZE BOX Temperature Controllers

are so simple to operate and so positive in action that even an unskilled attendant can obtain *uniform* results with practically no labor or attention.

"Set it and forget it" describes the situation because all the attendant need do is to "set" the controller for the required temperature and virtually "forget it." There is no time and labor wasted "juggling" the hand valves—no fluctuating temperatures — no splashing or chilling of the size—no imperfectedly sized or variable warps.

The "TAG" Controller requires *no compressed air* or other auxiliary motive power and can be adjusted to accurately regulate any temperature requirement between 160° and 235° F.



"Set it and forget it"

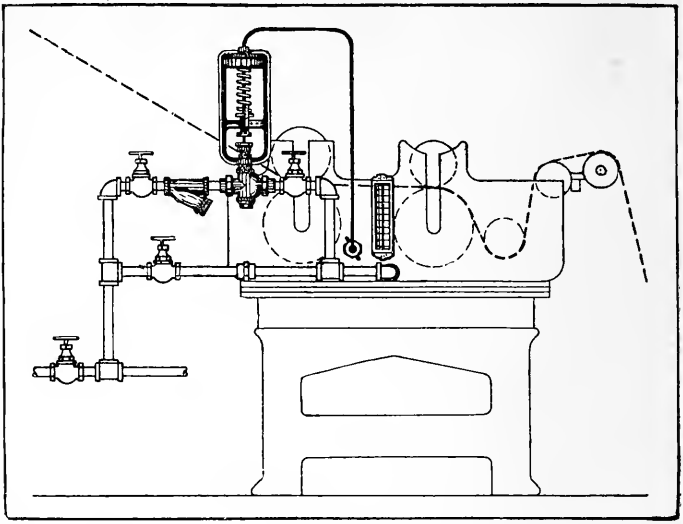


Illustration showing the "TAG" Self-Operating Temperature Controller Applied to a Size Box.

—*the only size box controller* which offers this wide and desirable range.

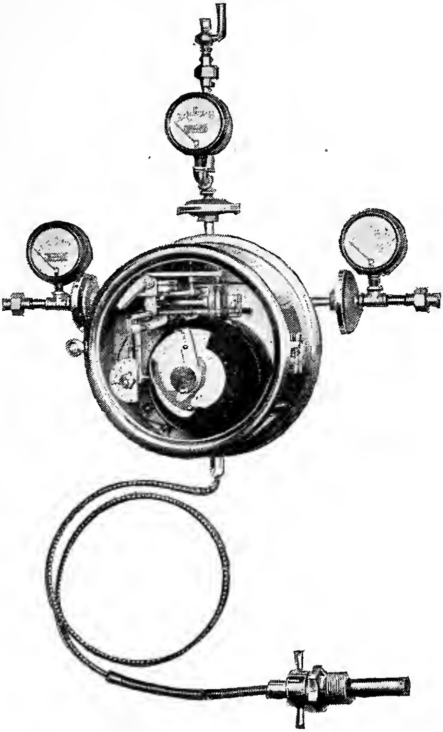
A special "TAG" size box fitting is supplied with each controller for the convenient reception and removal of the thermostatic bulb at the most *effective* location—an essential factor in automatic temperature control.

The flange of the "TAG" fitting on the inside of the box provides a *tight closure* between the copper sheathing and cast iron box—thus preventing the escape of "size" between the copper lining and iron body, which condition would sour the size and also disintegrate the iron.

All parts of the "TAG" Self-Operating Size Box Temperature Controller are strong and practically unbreakable —and the mechanism is so sensitive and responsive that there is *never* more than a 2-degree variation in the temperature of the size.

"TAG" COMBINATION AUTOMATIC TIME AND TEMPERATURE CONTROLLER

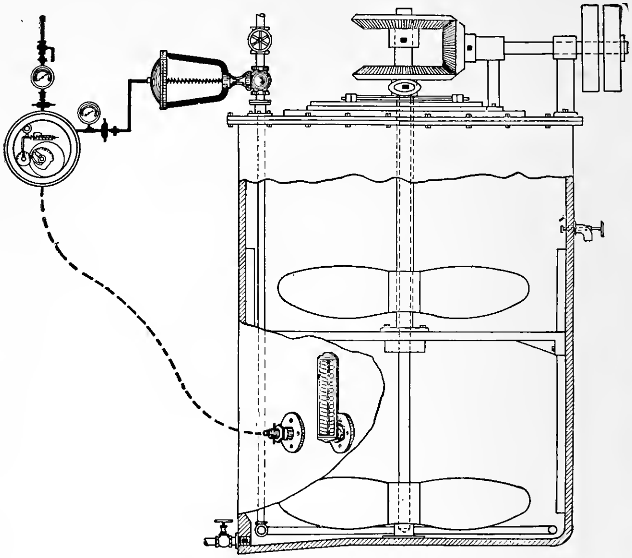
For Size Mixing or Cooking Kettles



Both in the boiling of potato starch and corn starch, it is absolutely essential to have the "size" mixture attain a *uniform* consistency but—this condition can only be produced by gradually raising the temperature in the mixing tubs or cooking kettles in a *definite* period of time and then holding it at the boiling point for a *certain* interval.

If the temperature is raised too fast, some of the starch granules become encased in the paste already formed and lumps result. On the other hand, if the temperature is brought up *too slowly,* the size becomes diluted and consequently is of a weak consistency, known as a "run-down" or "thin."

Insufficient heat fails to develop the characteristics of the particular starch and convert it into a uniform paste—while *excessive* heat gradually changes the starch into invert sugar, which has practically no value as a protecting or stiffening agent for the yarn.



"TAG" Combination Automatic Time and Temperature Controller Applied to a Mixing Kettle.

The exact degree of temperature and time intervals must be determined by experimental work on the particular formula used but after these important factors have been ascertained, the "TAG" Combination Automatic Time and Temperature Controller will follow these cycles *automatically.*

A fixed or adjustable cam, furnished with each controller, which is made to conform with the *individual* requirements of each mill, relieves the slasher-tender and over-seer of all work and worry because *all the attendant need do* is to open the hand steam valve wide and the "TAG" Combination Controller will do the rest.

There are two distinct processes under which all applications are made in applying these controllers to size mixing tubs or cooking kettles: 1—Combination time and temperature control of Potato Starch; 2—Combination time and temperature control of Corn Starch. Consequently, a different cam, operating as follows, is required for each starch:

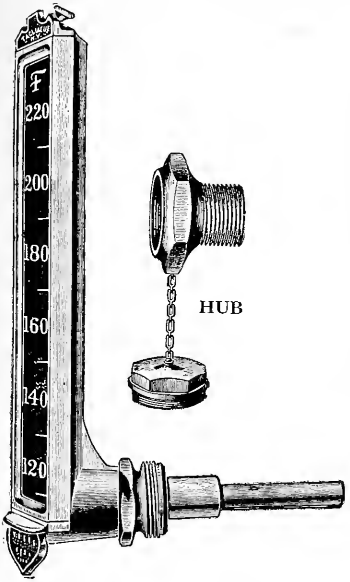
1. Potato Starch.—A cam which will raise the temperature to a boil in 30 minutes, a hold at that point for 30 minutes, then drop to 170° F., and an indefinite hold at that temperature until another cooking is started.

2. Corn Starch.—A cam which will raise the temperature to a boil or 212° F. in 30 minutes, a hold at that point for 60 minutes, a drop to 170° F. and held at that temperature indefinitely.

In specifying the design of the cam for a Combination Automatic Time and Temperature Controller, it would call for a minimum temperature of 70° F. and a maximum of 210° or 211° F. The adjustable cam can be arranged for a 2-hour rise and a maximum hold of two hours.

"TAG" INDICATING THERMOMETERS

for Cooking Kettles, Size Boxes, Dye Kettles, etc.



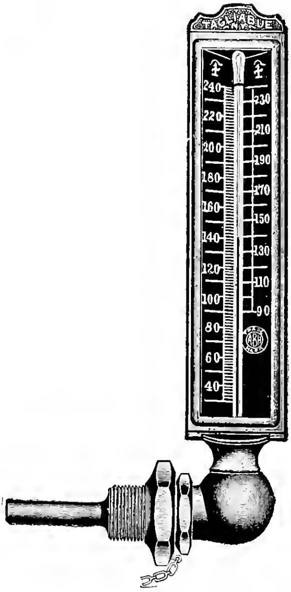
REGULAR FORM, RIGHT ANGLE STEM, Fixed Thread Connection.

These thermometers have been especially designed to meet the exacting requirements of textile processes and represent the *ultimate perfection* of 150 years of thermometer development and progress.

Permanent accuracy is guaranteed because each tube is "seasoned" to *prevent* future false readings due to shrinkage of the glass.

Actual temperature conditions are reproduced similar to those which the instrument will encounter in later use due to the "TAG" method of "pointing" and making a *special* scale for each thermometer.

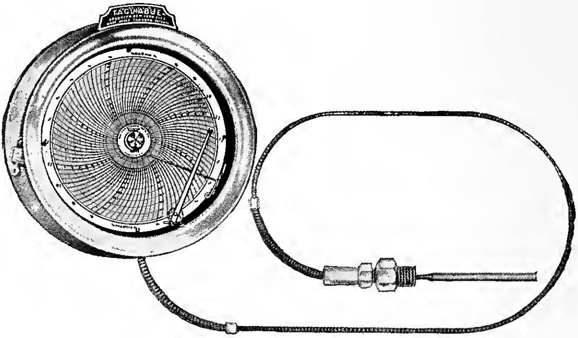
"TAG" Indicating or Industrial Thermometers can be supplied in *every* desired scale range and with *every* convenient form of connection, socket, etc.



LEFT SIDE FORM SEPARABLE Connection With Regular Socket attached.

"TAG" RECORDING THERMOMETERS

for Cooking Kettles, Size Boxes, Dryers, etc.



These recorders are extremely accurate and reliable because they have been designed along sound and correct principles, also due to their simplicity of construction. In fact, the accuracy, material and workmanship of "TAG" Recording Thermometers are *guaranteed*

Uniformity of results is assured because these instruments faithfully record *every* temperature operation, day or night, thereby *promoting* efficiency and helpful competition among the workmen in their efforts to produce praise-worthy charts.

Ease of reading is another valuable feature. It often happens that the temperature must be taken at a point which is *difficult* of access. In such case, the dial of the "TAG" Recorder can be mounted at a convenient location for *easy* observation.

"TAG" Recording Thermometers are made in both full-nickled bronze and japanned iron cases with nickel ring, in 8, 10 and 12-inch sizes and with 12-hour, 24-hour or 7-day charts.

MEMORANDA

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